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DOD SHUTTLE/ISS PAYLOAD SUPPORT CONTRACT (DPSC)

STS-93
POST MISSION REPORT
September 1999

- CCM-C-12
- LFSAH-01
- STL-B-02
- MEMS-01
- MSX-10
- SIMPLEX-06

CDRL A007 99 0175 PMR
CONTRACT #: F29601-97-R-0023
PREPARED BY: MUÑIZ ENGINEERING, INC.

Science Applications International Corporation
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INTRODUCTION

This document satisfies the requirements for the preparation of the STS-93 Post Mission Report, CDRL A007. This document was prepared by Muñiz Engineering, Inc. (MEI) under the DOD Space Shuttle Payload Support Contract (DPSC). Questions regarding the content of this report should be directed to Mr. Dave Hess, Space and Missile Systems Center/TELH, Johnson Space Center, Houston, TX, 281-483-3498; Mr. Mark Shumbera, Program Manager, MEI/DPSC, Houston, TX, 281-483-3529; or Mr. Luis Rodriguez, Mission Manager, MEI/DPSC, Houston, TX, 281-483-3520.

This document provides the mission overview, payload descriptions, mission objectives, payload activities and accomplishments, summary of console operations, and lessons learned for the DOD-sponsored payloads manifested on STS-93.

The DOD sponsored payloads for this mission were:

- **CCM-C-12**: Cell Culture Module - Configuration C
- **LFSAH-01**: Lightweight Flexible Solar Array Hinge
- **STL-B-02**: Space Tissue Loss - Configuration B
- **MEMS-01**: MicroElectroMechanical Systems
- **MSX-10**: Midcourse Space Experiment
- **SIMPLEX-06**: Shuttle Ionospheric Modification with Pulse Localized Exhaust

The following STS-93 video recordings have been archived to CD-ROM and are maintained in the Air Force Technical Library.

CCM-C Final Assembly
STL-B Final Assembly
STL-B Live Video Downlink
LFSAH On-Orbit Operations (8mm recording)
LFSAH On-Orbit Operations (HDTV recording)

Contact Jean Simpson at 281-483-3471 to view these videos.

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1.0 MISSION OVERVIEW

The primary objective of the STS-93 mission was to deploy the Chandra X-Ray Observatory, formerly known as the Advanced X-Ray Astrophysics Facility (AXAF). Chandra is the most sophisticated X-ray observatory ever built, and is designed to observe X-rays from high-energy regions of the universe, such as hot gases in the remnants of exploded stars.

The observatory has three major parts: (1) the X-ray telescope, whose mirrors will focus X-rays from celestial objects; (2) the science instruments, which record the X-rays so that X-ray images can be produced and analyzed; and (3) the spacecraft, which provides the environment necessary for the telescope and the instruments to work

The Space Test Program (STP) payload complement on STS-93 consisted of CCM-C, LFSAH, STL-B, MEMS, MSX, and SIMPLEX.

1.1 STS-93 FLIGHT OVERVIEW

Launch occurred at 00:31 a.m. EST on Friday, 23 July 1999.

The Mission Profile was as follows:

Orbiter: Columbia (26) / OV-102
Insertion Altitude: 153 nm (Direct Insertion)
Inclination: 28.45°

Launch Window: 1 hour, 56 minutes

Launch:	1st Attempt -Planned:	00:36 a.m. EST, KSC, 20 July 1999 (Aborted)
	2nd Attempt -Planned:	00:28 a.m. EST, KSC, 22 July 1999 (Postponed)
	3rd Attempt -Planned:	00:24 a.m. EST, KSC, 23 July 1999
	Actual:	00:31 a.m. EST, KSC, 23 July 1999

Mission Duration:	Planned:	4 days, 22 hours, 56 minutes
	Actual:	4 days, 22 hours, 49 minutes, 35 seconds
Landing:	Planned:	11:20 p.m. EST, KSC, 27 July 1999
	Actual:	11:20:35 p.m. EST, KSC, 27 July 1999

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Shuttle Crew (5)		DOD Payload Assignment
CDR:	Eileen M. Collins	CCM-C, MSX, SIMPLEX
PLT:	Jeffrey Ashby	MSX, SIMPLEX, STL-B, MEMS
MS1:	Catherine Coleman	CCCM-C, STL-B, LFSAH, MEMS
MS2:	Steven Hawley	MEMS, STL-B
MS3:	Michel Tognini (CNES)	LFSAH

DOD PAYLOAD	LOCATION
CCM-C	Middeck (MF71K)
LFSAH	Middeck (MF14G)
STL-B	Middeck (MF43E) (MF57H)
MEMS	Middeck (MF71M)
MSX	N/A
SIMPLEX	N/A

1.2 EXPERIMENT DESCRIPTION AND OBJECTIVES

1.2.1 CCM-C

The objectives of the payload are to validate models for muscle, bone, and endothelial cell biochemical and functional loss induced by microgravity stress; to evaluate cytoskeletal development, metabolic factors, membrane integrity and protease activity in target cells; and to test tissue loss pharmaceuticals for efficacy. The experiment fits into a single standard middeck locker, which has a modified locker door with its panels removed. The unit draws cooling air in through an opening below the control panel. The air is then vented across the instrument panel and into the crew cabin, using a lexan deflector that is mounted in the upper right-hand corner of the control panel (see Figure 2-1). The experiment is controlled by an internal computer; however, a crew interface (control panel) is provided in the lower left-hand corner for health and status information and for in-flight anomaly resolution. A detailed description of the control panel functions is given in Section 5.0. The experiment requires continuous power for thermal conditioning of the oxygen/nutrient supply and will function from prelaunch through postlanding. The payload requires GSE power after handover and just prior to installation into the middeck; Orbiter power while installed in the middeck; and GSE power during postlanding and prior to delivery.

1.2.2 LFSAH

The Lightweight Flexible Solar Array Hinge (LFSAH) experiment provides a means to test a lightweight, low-shock, reliable mechanism for solar array deployment. Hinges are the primary mechanism used to deploy spacecraft solar arrays that are folded together for launch. Once on-orbit, these solar array systems are deployed, or unfolded and used to generate power for the spacecraft. Flight testing of the hinges provides an opportunity to evaluate various hinges in a realistic environment, and also allows investigators to verify the mechanical design data and to evaluate the dynamic properties of the hinges. The LFSAH consists of six hinges composed of Shape Memory Alloys (SMA). The key advantages of SMA hinges over other hinges include low-shock controlled deployment, fewer parts, lighter weight, higher reliability, and easier production and assembly. The LFSAH on STS-93 provides a way to test this technology in a weightless environment prior to being applied to future spacecraft design, such as to the New Millennium-Earth Observer-1 (EO-1) experiment and to the Deep Space 3 (DS3) spacecraft.

The LFSAH consists of six independent hinge assemblies which are activated via switch throws by the crew. The hinges vary by type, size, and amount of use, as shown in Table 2-1. Four of the six hinges are constructed of shape memory alloy, while the remaining two are considered super elastic, consisting of spring steel. Each hinge is of either standard size or sub-scale. The standard hinge measures 2.75” x 1.055”, while the sub-scale hinge measures 2.75” x 0.5”. All of the hinges have experienced limited activity, except for Hinge 4, which has been cycled dozens of times. The power, temperature, and displacement data obtained during each hinge activation is recorded and stored internally to the payload, using a PCMCIA memory card.

The LFSAH uses standard orbiter 28-volt DC power and a 28-volt DC cable. A 2-amp ceramic fuse protects the main power circuit, and a spare fuse is located in the fuse box on the experiment.

Nominal experiment activities involve operating the experiment per the orbit timeline and documenting these activities with 35mm still photos and 8mm video recording. In-flight anomaly resolution activities are limited to power-cycling the hardware and performing a fuse change-out.

1.2.3 STL-B

The STL-B experiment module is a single middeck locker assembly with a locker door modified for crew interface via the front panel (see Figure 2-1). The module contains the specific cells being studied, optical chambers for viewing all cell activity, media (sterile water) for sustained growth, tubing, pumps for circulating the media, valves for introducing the media, fluorescent lights for on-orbit germination, a video microscope attached to an XYZ translator, a video signal processing unit, and various thermal control devices. From prelaunch through postlanding, these cells are automatically supplied with media; however, they will not become active until the internal lighting system is activated.

The objectives of the STL-B payload on STS-93 are to study the effects of microgravity on the nuclear migration in fern spore cells. The STL-B will allow scientists to watch how single cells, which normally use gravity to guide their development, react when that guidance system is removed in microgravity. The cells that will be watched by the STL-B microscopy module are single spore cells of the fern Ceratopteris richardii. These cells are activated to emerge from dormancy by a light signal and have a nucleus that begins in a central position in the cell. After activation, the nucleus moves in a random walk restricted near the cell center for approximately the first twenty hours. Then, under the guidance of 1-G on earth, the nucleus suddenly migrates to the lower part of the cell. There it divides, producing two cells, a smaller one that develops into a root-like rhizoid, and a larger one that develops into the leafy part of the plant, the prothallus. The gravity-directed migration of the nucleus exactly predicts the direction of the emergence and growth of the rhizoid after the spore germinates. Furthermore, the unequal cell division that results from the asymmetric positioning of the nucleus after its downward migration may be a prerequisite for two different cell types to form, rhizoid and prothallus. The main objective of the STS-93 STL-B experiment is to find out whether, in the absence of a strong gravity signal, the nucleus will migrate randomly or not at all; and if not, whether the failure to migrate will prevent normal development of the rhizoid and prothallus.

The STL-B can also address a second area concerning the "random walk" of the nucleus about the center of the cell. This movement, as well as the later downward movement of the nucleus, is driven by molecular motors. The possibility exists that these molecular motors need the tension and compression forces that are set up in the cell by gravity in order to be turned on. The STL-B experiment will, therefore, provide an opportunity to observe whether in microgravity the molecular motors will operate normally, or will fail to turn on, leaving the nucleus motionless in the center of the cell. In this second area, the STL-B may provide insight into how these molecular motors, which are common to all plant and animal cells, can be controlled.

1.2.4 MEMS

The objective of the MicroElectroMechanical Systems (MEMS) experiment is to identify low-cost, easily producible, integrated space micro/nanosystems for the DOD and NASA. To do this, the experiment will verify the operability of integrated functional subsystems, and will compare and evaluate commercial MEMS and micro/nanoelectronics for space applications. For this mission, the MEMS will evaluate the performance of a tri-axial, high-G accelerometer; two high-data-rate, high-G data loggers; three different types of micro-gyros; five single-axis, high-sensitivity accelerometers; some active and passive nanoelectronics experiments; a thermal control device; and seven environmental devices (e.g. pressure, temperature, and humidity sensors, as well as CO, CO_2, CH_4, and H_2 sensors).

The MEMS utilizes a standard orbiter 28-volt DC power cable and 28-volt DC power. A 5-amp ceramic fuse protects the main power circuit, with a spare fuse located in the fuse box on the experiment.

Nominal experiment activities involve operating the experiment per the orbit timeline and documenting these activities with 35mm still photos and 8mm video recording. In-flight anomaly resolution activities are limited to power-cycling the hardware and performing a fuse change-out.

1.2.5 MSX

MSX is a standard middeck payload with no hardware aboard the Shuttle. The crew and orbiter are required to participate cooperatively in achieving MSX payload objectives. The basis of MSX is to use the orbiter as a target for a separate DOD orbiting satellite, the MSX, which is located in an 889-km altitude orbit inclined 98° to the Earth's equator.

The MSX is an active, cooperative experiment consisting of orbiter PRCS and OMS jet firings that take place in specific attitudes relative to the MSX line of sight. This configuration allows the MSX satellite to observe far-field plumes by the MSX satellite, which are unattainable in a laboratory. Overall, plume measurements are expected to provide information about molecular processes at high-collision velocities. Additionally, these measurements will also provide data about Shuttle engine efficiency diagnostics, support for spacecraft contamination models, and the identification of flow field diagnostics for space station approach applications.

1.2.6 SIMPLEX

SIMPLEX is a low-impact payload with no flight hardware and is somewhat similar to MSX and AMOS. The orbiter crew fires OMS thrusters at specific times and attitudes when the orbiter is located within view of one of five SIMPLEX radar tracking sites: Arecibo, Puerto Rico; Kwajalein, Marshall Islands; Millstone Hill, Massachusetts; Alice

Springs, Australia; or Jicamarca, Peru. Of all of these sites, the Arecibo site also uses a low-level laser for observations.

To accomplish these observations, the ground-based radars probe the ionosphere in the vicinity of the Shuttle in order to detect artificial irregularities caused by the orbital kinetic energy of spacecraft exhaust vapors. The objective is to develop models of the physics which occur in the ionosphere after an Orbiter OMS burn and to determine the source of Very High Frequency (VHF) radar echoes caused by the orbiter and its OMS engine firings.

The SIMPLEX is manisfested for approximately 24 Shuttle missions. All the studies will be completed in approximately three years.

2.0 PAYLOAD ACTIVITIES AND ANOMALIES

2.1 PRELAUNCH

2.1.1 CCM-C

The CCM-C payload was processed at Hangar L at CCAFS. Each of the two CCM-C units were approved as candidates for flight; however, only one would actually fly, while the second unit would be used as a back-up to the flight unit. The prelaunch processing for the first launch attempt was nominal, and the final assembly procedures were completed without any problems. A 48-hour scrub turn-around between the first and the second launch attempts occurred. During this time, the CCM-C locker was removed from the orbiter and returned to the PI for refurbishment of the biology.

When the locker arrived at Hangar L, the temperature readings were very high for the cooling unit as well as for two of the three rails. When the unit was disassembled, the PI discovered that there had been an oxygenator leak in the tubing which leaked fluid throughout the entire inner containment assembly (second level of containment). Therefore, the refurbishment of this initial flight unit was going to be more extensive than normal. The PI decided to use the back-up unit as the flight unit for the second launch attempt, although both units would require assembly in order to satisfy the requirement of having a back-up unit or ground control unit. During final assembly for the second launch attempt, the flight unit experienced some problems when three of the six front plate screws were sheared off during installation. This forced the PI to consider using the back-up unit as the flight unit for the second launch attempt. At this point, the back-up unit experienced several problems during its final assembly, namely that the o-ring used to seal the inner containment assembly would not seat properly around the edge of the box. Once this was fixed, the unit was pressure tested. At this time it became evident that there was a small crack in the outer containment assembly adjacent to the seal around the cooling unit. Once this problem was fixed and once other leaks were addressed using vacuum grease, the unit was ready for flight and installed into its locker. The back-up unit was continuing to receive attention as the sheared screws were removed and replaced. However, another face plate screw was eventually sheared off, which confirmed that this unit would remain the back-up unit for the second launch attempt.

A 24-hour scrub turn-around between the second and the third launch attempts occurred. The PI decided not to refurbish the biology during this 24-hour period, so the payload stayed within its locker in the orbiter. The PI requested that someone check the temperature readouts of the CCM-C in the orbiter. The temperatures of two of the rails were slightly high, but by this point it was too late to try a removal of the locker from the orbiter. Eventually, the CCM-C was successfully launched into space on the third launch attempt.

2.1.2 LFSAH

The LFSAH payload was processed prior to flight without anomalies. The payload hardware was provided to USA Flight Crew Equipment in support of the STS-93 bench review. After bench review the hardware was packed in its flight locker and sent to KSC. The USA FCE personnel at KSC provided digital images of the LFSAH after its arrival to their lab and e-mailed these images to JSC. This step was taken in order to confirm that none of the hinges deployed during shipment. The locker containing the LFSAH was inserted into the orbiter during nominal crew compartment integration and maintained its position in the orbiter despite the multiple launch attempts.

2.1.3 STL-B

The STL-B payload was processed at Hangar L at CCAFS. Each of the two STL-B units were tested for bonding resistance. One of the units did not meet the bonding requirement and, therefore, could be used only as a ground unit. The other STL-B unit exceeded the middeck IDD bonding requirement, but was within the exceedance level that had already been approved by NASA for STS-93. During prelaunch processing for the first launch attempt, the PI attempted several times to obtain a satisfactory sample of fern cells to be inserted into the payload. Since these cells were light-sensitive, their exposure to light was limited as much as possible. A 48-hour scrub turn-around between the first and the second launch attempts occurred. During this time, the STL-B locker was removed from the orbiter and returned to the PI for refurbishment of the biology. During prelaunch processing for the second launch attempt, the PI again attempted several times to obtain a satisfactory sample of fern cells to be inserted into the payload. The flight hardware was turned over to NASA and installed into the orbiter during the nominal late-load installation time frame. A 24-hour scrub turn-around between the second and the third launch attempts occurred. The PI decided not to refurbish the biology during this 24-hour period, so the payload stayed within its locker in the orbiter and was successfully launched into space on the third launch attempt.

2.1.4 MEMS

The MEMS payload was shipped to KSC by the Flight Crew Equipment Processing Contractor (FEPC) after the Bench Review. MEMS was received at KSC by the Flight Crew Equipment (FCE) personnel and was held until approximately L-11 days. MEMS was then turned over to the PI for prelaunch processing. This processing consisted of installing batteries and downloading software into the G-Loggers, testing the software of the main computer unit, installing the passive radiation detector around the nano-electronic circuits, replacing the doser bottles for the gas sensors, cleaning the unit to the visibly clean level, performing a ground resistance test, and verifying the flight power cable connection to the MEMS power plug. All activities were completed with only two anomalies. First, one of the G-Loggers had to be replaced because it failed to accept the downloaded software. This G-Logger was intended to provide high-speed data to the main unit during ascent. The replacement G-Logger, however, could only provide low-speed data. The slower data speed should not affect the results of the experiment since this communication was purely redundant (in terms of launch triggering and data recording). Second, the Thermal Control Device (TCD) was observed to be inoperative. The PI stated that no action would be taken to change this device, and he also indicated that it was probably too early in the development phase of this technology to begin testing it. This is a lesson learned from the PI's perspective, and the PI needs to look closely at the types of technology that are integrated into the MEMS testbeds to verify their feasibility for test flights.

The MEMS payload was powered up at 07:33 EDT on 22 July 1999.

2.1.5 MSX

Several iterations of flight analyses and designs were performed prior to the flight to identify and schedule MSX opportunities in the flight plan. This early identification also helped to identify and reserve operational time slots for the MSX satellite. The PI for MSX identified three Data Collection Events (DCEs) for this mission. Accomplishment of these three DCEs will result in the completion of the MSX program with NASA.

The first DCE was identified for orbit 31 around 1/21:03:22 Mission Elapsed Time (MET). This test was scheduled to be a PRCS RAM/WAKE burn, with the thrust vectors biased 68° up and down to the velocity vector (i.e. orbiter nose biased 68° down).

The second DCE was identified for orbit 47 around 1/21:06:32 MET. This test was scheduled to be a 90° OMS and PRCS burn, with the thrust vectors biased 90° up (i.e. orbiter nose pointing directly at the Earth).

The third DCE was identified for orbit 65 around 3/21:07:59 MET. This test was scheduled to be an OMS WAKE burn followed by a PRCS RAM/WAKE burn, with the OMS thrust vector biased 30° up (i.e. orbiter nose down 30°).

There were no pre-flight anomalies for MSX.

2.1.6 SIMPLEX

Several iterations of flight analyses and designs were performed prior to the flight to identify and schedule SIMPLEX opportunities in the flight plan. This early work also helped to identify and reserve operational time slots for the SIMPLEX radar sites. The PI for SIMPLEX identified six opportunities for this mission.

The first opportunity was identified for orbit 18 around 1/02:41:18 MET. This test was scheduled to be a left OMS RAM burn over the defined area for the Alice Springs Over The Horizon Radar (OTHR).

The second opportunity was identified for orbit 21 around 1/06:37:54 MET. This test was scheduled to be a dual OMS RAM burn over the Jicamarca radar site.

The third opportunity was identified for orbit 34 around 2/01:22:14 MET. This test was scheduled to be a dual OMS RAM burn over the Kwajalein radar site.

The fourth opportunity was also identified for orbit 34 but around 2/02:41:52 MET. This test was scheduled to be a right OMS WAKE burn over the defined area for the Alice Springs Over The Horizon Radar (OTHR).

The fifth opportunity was identified for orbit 50 around 3/02:42:35 MET. This test was scheduled to be a left OMS RAM burn over the defined area for the Alice Springs Over The Horizon Radar (OTHR).

The sixth and final opportunity was identified for orbit 65 around 4/00:22:09 MET. This test was scheduled to be a dual OMS RAM burn over the Arecibo radar site.

There were no pre-flight anomalies for SIMPLEX.

2.2 ON-ORBIT

2.2.1 CCM-C

The CCM-C performed nominally on-orbit. The crew performed CCM-C status checks twice a day throughout the mission. During the first portion of the mission, two of the rail temperatures were slightly higher than anticipated, but these eventually dropped to within the expected range.

2.2.2 LFSAH

The LFSAH performed as expected during payload operations on-orbit. All six of the hinges deployed nominally. The crew did not turn on the photo floodlight during the first hinge deployment, so the video footage of the deployment is difficult to see. It is assumed that the crew was attempting to limit the cabin lighting in order to accommodate the SUISS payload. Once the crew was able to improve the lighting, the remaining video footage of the hinge operations is easily seen on the video tape.

2.2.3 STL-B

The STL-B was initialized per the timeline at approximately 01/01:10 MET. Four separate time frames of live video downlink were provided throughout the mission. Several of these downlinks were interrupted due to a lack of consideration by MOD personnel for KU-Band coverage, and at other times the downlinks were interrupted or delayed due to conflicts on-orbit with other middeck secondary payloads, particularly the SUISS payload. During each of these downlinks, the microscopy camera focused well in chamber A, but did not focus well in either chamber B or chamber C. Each time, the crew was asked to perform the “Manual and Re-zero Camera Operations” procedure contained in the Payload Ops Checklist, and two or three times the crew performed this procedure without prompting from the ground. The crew also performed a status check of the STL-B twice per day at which time they would read the STL-B temperature from the LCD display. The temperature of the STL-B stayed within its limit of 27-31° C throughout the entire mission.

2.2.4 MEMS

Aside from the crew's inability to detect any changes in the TCD (which was expected following the prelaunch processing anomaly), the MEMS appears to have operated nominally for the entire flight. The MEMS was left powered on for de-orbit.

2.2.5 MSX

The planned pre-flight DCE opportunities shifted in time and in orbit due to a shuttle launch delay of 2 days, 23 hours, 55 minutes; consequently, the new DCE opportunities occurred at the following times and orbits:

The first MSX DCE occurred on orbit 21 with a TIG time of 1/05:58:55 MET (205/10:29:55 GMT). The burn was nominal (PRCS RAM/WAKE, nose biased 68° down). The PI has stated that the MSX acquired and tracked the Orbiter's S-Band signal; however, it will take more time to determine how much data was collected for this event.

The second MSX DCE occurred on orbit 37 with a TIG time of 2/06:01:16 MET (206/10:32:16 GMT). The burn was nominal (PRCS RAM/WAKE, nose biased 68° down). The PI has stated that the MSX acquired and tracked the Orbiter's S-Band signal. He also stated that part of this interval included viewing in exclusion zones, which the PI is working on internally. Additional time is needed to determine how much data was collected for this event.

The third MSX DCE occurred on orbit 53 with a TIG time of 3/06:03:16 MET (207/10:34:16 GMT). The burn was nominal (PRCS RAM/WAKE, nose biased 68° down). The PI has stated that the MSX acquired and tracked the Orbiter's S-Band signal. He also stated that part of this interval included viewing in exclusion zones, which the PI is working on internally. A preliminary look at the data indicates the presence of plumes in the UV narrow field view imager; however, additional time is needed to determine how much data was collected for this event.

2.2.6 SIMPLEX

Because one of the main engines on the orbiter sprang a leak during ascent, the orbiter failed to achieve its designed orbit, culminating in a seven-mile shortage in the desired perigee. This shortage, coupled with the fact that the flight dynamics officer (FDO) and the propellant officer (PROP) were required to conserve fuel and maintain nominal landing opportunities, kept the orbiter in a more elliptical orbit than was planned pre-mission. This new orbit changed the ground tracks slightly and decreased the elevation angles of the pre-planned SIMPLEX opportunities. After the first appearance of a plume in the radar beam (the Jicamarca radar), the PI determined that the pre-planned dual OMS burns for Kwajalein and Arecibo should be changed to single OMS burns of longer duration, allowing for a larger interaction volume (at the cost of interaction density). This done, the actual results of the SIMPLEX activities are summarized below:

The first SIMPLEX opportunity still occurred on Orbit 18 but at a slightly different time of 1/02:38:35 MET (205/07:09:35 GMT). The burn performed was a left OMS RAM. The PI reported that the burn was observed at the smaller Doppler radar at Alice Springs. The main radar was in use by other requirements, and since this radar is an operational one, scientific research must take a back seat. The PI said that the Orbiter was detected during this pass.

The second SIMPLEX opportunity still occurred on Orbit 21 but at a slightly different time of 1/06:34:56 MET (205/11:05:56 GMT). The burn performed was a dual OMS WAKE. The PI reported that the Jicamarca burn was observed by incoherent scatter radar. The Jicamarca staff verified acquisition of the orbiter in the radar sidelobes and in the formation of an ionospheric hole in the expected place. Further analysis will be needed to find predicted affects from ion beams produced in the OMS plume of the Space Shuttle.

The third SIMPLEX opportunity still occurred on Orbit 34 but at a slightly different time of 2/01:18:01 MET (206/05:49:01 GMT). The burn performed was a left OMS RAM. The PI reported that the Kwajalein staff observed significant and extended backscatter in the UHF for the period of the burn and continued to take data for approximately one hour after the burn. Further analysis will be needed to determine the significance of this data.

The fourth SIMPLEX opportunity still occurred on Orbit 34 but at a slightly different time of 2/02:38:31 MET (206/07:09:31 GMT). The burn performed was a right OMS WAKE. The PI reported that the burn was observed at the smaller Doppler radar at Alice Springs. The main radar was in use by other requirements, and since this radar is an operational one, scientific research must take a back seat.

The fifth SIMPLEX opportunity still occurred on Orbit 50 but at a slightly different time of 3/02:38:34 MET (207/07:09:34 GMT). The burn performed was a right OMS RAM. No report has been received from the PI as to what was observed at Alice Springs.

The sixth and last SIMPLEX opportunity still occurred on Orbit 65 but at a slightly different time of 4/00:17:59 MET (208/04:48:59 GMT). The burn performed was a right OMS RAM. The PI reported that the 430 MHz radar was operated using a coded pulse to scatter from the electrons in the ionosphere when the STS-93 burn over Arecibo occurred. The radar recorded the orbiter as well as the affects on the ionosphere. An additional instrument at the Arecibo observatory, called an ionosonde, showed an ionospheric hole formed to the side of the burn position 2 minutes after the event, interpreted as the drifted plasma density depression. Analysis has started on both the radar and ionosonde data, and preliminary results should be available in a few days.

2.3 POST-LANDING

2.3.1 CCM-C

The CCM-C was returned to the PI at Hangar L approximately three hours after landing. The unit appeared to be in nominal condition, and the temperature readings continued to be within the nominal range.

2.3.2 LFSAH

The LFSAH was returned to the USA FCE lab during nominal de-stow operations. The LFSAH hardware and associated 8mm video tape were returned to the payload representative approximately 11 hours after landing. The LFSAH hardware was then shipped to the PI in Littleton, Colorado, and the 8mm video tape was hand-carried to JSC where duplicate copies were made.

2.3.3 STL-B

The STL-B was returned to the PI at Hangar L approximately three hours after landing. The unit appeared to be in nominal condition. The PI spent time trying to determine the cause for the camera focus problems that were experienced on-orbit. It appeared that the camera worked well when in an upright orientation in 1-G; however, when the STL-B unit was placed on its side in 1-G, the camera did not zoom in and out properly, causing the field of view to be out-of-focus. MOD wrote an In-Flight Anomaly (IFA) due to the camera problems experienced on-orbit. The PI will continue to determine the cause of this problem, which could relate directly to the problem experienced on-orbit. Their initial findings indicate that the limit switch used to prevent the camera from bumping the cell chamber was being triggered early, causing the camera to stop its forward motion. OL-AW is in the process of confirming the cause of the anomaly and writing a closure to the IFA.

2.3.4 MEMS

The MEMS was powered on during the landing of the orbiter. KSC personnel removed the MEMS locker and delivered it to the assigned laboratory in the O&C building. The PI then downloaded the data onto a Jazz drive, removed the passive radiation detector, and shipped the hardware back to his facility. The locker and foam were returned to FCE personnel, and the passive dosimeter was returned to JSC and sent to the Space Radiation Analysis Group (SRAG) for analysis. Data is currently being gathered for postflight analysis.

2.3.5 MSX

Postflight data from the orbiter downlink has been gathered, formatted, and delivered to the PI for analysis. Further analyses will be performed over the next several months to interpret the data received.

2.3.6 SIMPLEX

Postflight data from the orbiter downlink has been gathered, formatted, and delivered to the PI for analysis. Further analyses will be performed over the next several months to interpret the data received.

3.0 MEASURE OF MISSION ACCOMPLISHMENTS

3.1 CCM-C

The CCM-C met all of its mission objectives. The rail temperatures stayed within their nominal ranges for the majority of the mission. The initial high temperatures were thought to be associated with the additional 24 hours of time that the CCM-C was in the orbiter in a face-down orientation. The temperature of the cooling chamber stayed within its nominal range, although the PI had anticipated that it would be lower than it was. The PI is in the process of analyzing the science results; however, an initial assessment leads the PI to believe that the mission was a success.

3.2 LFSAH

The LFSAH met all of its expected mission objectives. All six of the hinges deployed as expected. The PI received the hardware two days after the mission ended and began analyzing the data. The results of these analyses will be provided to OL-AW as soon as they are available.

3.3 STL-B

The STL-B met all of its mission objectives since it received the four live video downlinks (minimum of two required) and appeared to receive the requested amount of on-board video taping during the key time frames identified during pre-flight. Only one of the four live downlink sessions received the full 45 minutes of continuous coverage. However, each of the live downlink sessions provided the PI with an opportunity to assess the development of the biology and make adjustments to the focus plane of the camera. The PI is continuing to investigate the cause of the camera focus problem. The PI is also comparing the flight biology to the ground control unit to determine the effects of microgravity on the development of the biology. The on-board video tapes are currently being processed at JSC and will be made available to the PI within one to two weeks after the mission. The minimum science requirements were to assess the development of 20 spores. The initial assessment shows that the cells from Chamber A alone should exceed this minimum requirement; however, the data from Chambers B and C is mostly unusable.

3.4 MEMS

100% of the required activities were performed for the MEMS payload. A preliminary look at the data indicates that the Testbed functioned as planned. The sensors were functioning as soon as power was applied and continued to give data until power was removed. Initial plots of several accelerometer outputs, including the G-loggers on the back panel, showed launch accelerations and an OMS burn that are consistent with Shuttle flight data. The chemical sensors provided data as well, but post flight calibrations are required to interpret the results. Data from the micro-gyros have not been examined yet. The micro-cavity structure appeared to have maintained its structural integrity, and the surrogate fuel loads remained intact. The micro-thermal control experiment was not reported as fully functioning, but the experimenter will need to evaluate its performance in his laboratory. The nanoelectronics experiment will be returned to the experimenter for evaluation. This first examination indicates that the experiments were completely successful. Still remaining is an evaluation of the data and its comparison to flight data in order to perform a detailed, comparative analysis of the performance of the individual microdevices.

3.5 MSX

The STP and the NASA flight control team both performed operations as planned. The planned pre-flight DCE opportunities shifted in time and in orbit due to a shuttle launch delay of 2 days, 23 hours, 55 minutes; consequently, the new DCE opportunities occurred at the following times and orbits:

The first MSX DCE occurred on orbit 21 with a TIG time of 1/05:58:55 MET (205/10:29:55 GMT). The burn was nominal (PRCS RAM/WAKE, nose biased 68° down). The PI has stated that the MSX acquired and tracked the Orbiter's S-Band signal; however, it will take more time to determine how much data was collected for this event.

The second MSX DCE occurred on orbit 37 with a TIG time of 2/06:01:16 MET (206/10:32:16 GMT). The burn was nominal (PRCS RAM/WAKE, nose biased 68° down). The PI has stated that the MSX acquired and tracked the Orbiter's S-Band signal. He also stated that part of this interval included viewing in exclusion zones, which the PI is working on internally. Additional time is needed to determine how much data was collected for this event.

The third MSX DCE occurred on orbit 53 with a TIG time of 3/06:03:16 MET (207/10:34:16 GMT). The burn was nominal (PRCS RAM/WAKE, nose biased 68° down). The PI has stated that the MSX acquired and tracked the Orbiter's S-Band signal. He also stated that part of this interval included viewing in exclusion zones, which the PI is working on internally. A preliminary look at the data indicates the presence of plumes in the UV narrow field view imager; however, additional time is needed to determine how much data was collected for this event.

In all, STP and the NASA performed 100% of the pre-mission test requirements. While the MSX satellite did track the orbiter for all three opportunities, additional time will be required to analyze the data. All required postflight data has been retrieved and forwarded to the PI to assist in these analyses. However, this mission does complete the MSX payload requirements for the Shuttle.

3.6 SIMPLEX

The STP and the NASA flight control team both performed operations as planned. Because one of the main engines on the orbiter sprang a leak during ascent, the orbiter failed to achieve its designed orbit, culminating in a seven-mile shortage in the desired perigee. This shortage, coupled with the fact that the flight dynamics officer (FDO) and the propellant officer (PROP) were required to conserve fuel and maintain nominal landing opportunities, kept the orbiter in a more elliptical orbit than was planned pre-mission. This new orbit changed the ground tracks slightly and decreased the elevation angles of the pre-planned SIMPLEX opportunities. After the first appearance of a plume in the radar beam (the Jicamarca radar), the PI determined that the pre-planned dual OMS burns for Kwajalein and Arecibo should be changed to single OMS burns of longer duration, allowing for a larger interaction volume (at the cost of interaction density). The actual results of the SIMPLEX activities are summarized below:

The first SIMPLEX opportunity still occurred on Orbit 18 but at a slightly different time of 1/02:38:35 MET (205/07:09:35 GMT). The burn performed was a left OMS RAM. The PI reported that the burn was observed at the smaller Doppler radar at Alice Springs. The main radar was in use by other requirements, and since this radar is an operational one, scientific research must take a back seat. The PI said that the Orbiter had been detected during this pass.

The second SIMPLEX opportunity still occurred on Orbit 21 but at a slightly different time of 1/06:34:56 MET (205/11:05:56 GMT). The burn performed was a dual OMS WAKE. The PI reported that the Jicamarca burn was observed by incoherent scatter radar. The Jicamarca staff verified acquisition of the orbiter in the radar sidelobes and the formation of an ionospheric hole in the expected place. Further analysis will be needed to find predicted effects from ion beams produced in the OMS plume of the Space Shuttle.

The third SIMPLEX opportunity still occurred on Orbit 34 but at a slightly different time of 2/01:18:01 MET (206/05:49:01 GMT). The burn performed was a left OMS RAM. The PI reported that the Kwajalein staff observed significant and extended backscatter in the UHF for the period of the burn and continued to take data for approximately one hour after the burn. Further analysis will be needed of this data to determine its significance.

The fourth SIMPLEX opportunity still occurred on Orbit 34 but at a slightly different time of 2/02:38:31 MET (206/07:09:31 GMT). The burn performed was a right OMS WAKE. The PI reported that the burn was observed at the smaller Doppler radar at Alice Springs. The main radar was in use by other requirements, and since this radar is an operational one, scientific research must take a back seat.

The fifth SIMPLEX opportunity still occurred on Orbit 50 but at a slightly different time of 3/02:38:34 MET (207/07:09:34 GMT). The burn performed was a right OMS RAM. No report has been received from the PI as to what was observed at Alice Springs.

The sixth and last SIMPLEX opportunity still occurred on Orbit 65 but at a slightly different time of 4/00:17:59 MET (208/04:48:59 GMT). The burn performed was a right

OMS RAM. The PI reported that the 430 MHz radar was operated using a coded pulse to scatter from the electrons in the ionosphere when the STS-93 burn over Arecibo occurred. The radar recorded the orbiter as well as the affects on the ionosphere. An additional instrument at the Arecibo observatory, called an ionosonde, showed an ionospheric hole formed to the side of the burn position 2 minutes after the event, interpreted as the drifted plasma density depression. Analysis has started on both the radar and ionosonde data, and preliminary results should be available in a few days.

In all, STP and the NASA performed 100% of the pre-mission test requirements. The PI is very pleased with the data that was obtained with this mission. However, additional time will be required to perform detailed data analysis. All required postflight data has been retrieved and forwarded to the PI to assist in these analyses.

4.0 LESSONS LEARNED

4.1 CCM-C

Maintain the requirement to have two units available for flight in case the primary flight unit experiences problems during final assembly procedures.

Consider requesting that the temperatures on the LCD display be relayed to the PI after the locker has been installed into the orbiter and during the Integration and Verification Test (IVT). Thus, if the temperatures were out of the nominal range, a one-for-one swap could be made between the flight unit and the back-up unit.

4.2 LFSAH

Include everything in the crew procedures that is necessary in order to monitor the on-orbit activity from the POCC, which includes specifically stating items in the procedures, such as “Notify MCC prior to starting payload operations,” or “Notify MCC once payload operations have been completed.”

Explicitly state the set-up and lighting requirements for any photographic or video footage required for the payload. This will preclude operating experiments in poor lighting.

4.3 STL-B

Confirm that all exceedances are approved and properly documented prior to departing for KSC for prelaunch processing. The bonding exceedance had been approved by JSC, but the proper documentation in the Crew Compartment Configuration Drawing (CCCD) had not been updated to reflect this approved exceedance.

Request that all on-board video tapes be turned over to the PI representative postflight through the Launch Site Dispositioning Report (LSDR). Otherwise, the video tapes are removed from the orbiter and sent directly to JSC for processing, which delays the PI in his postflight analysis and could potentially degrade the quality of video imagery inherent in video duplication processes.

Maintain the requirement to have two units available for flight in case the primary flight unit experiences problems during final assembly procedures.

4.4 MEMS

When flying new technology with which the crew will interface, STP should verify that the technology is mature enough to work at all. The thermal control device flown on this experiment did not work from the point of receipt from the PI. This caused the crew to strain to see any changes during on-orbit operations.

Payloads requiring some type of visual inspection during on-orbit operations should avoid locations close to the floor, ceiling or walls, to allow the crew members room to position themselves in good viewing aspects. MEMS was close to the floor and wall of the Shuttle, and the crew commented that it was difficult to position themselves to the thermal control device to see anything.

4.5 MSX

None

4.6 SIMPLEX

None

5.0 FLIGHT LOG

FLIGHT/SIM/TEST/ID	DATE	ORB	CONSOLE POSITION	PAGE
STS-93	18 JULY 99		DOD REP	1 of 22

TIME	FLIGHT EVENTS/HISTORY/BRIEFINGS
17:10	Hols on
	Beeped Hellner - Got status of P/Ls
18:20	Hoge on
18:30	Systems brief starting / Rodriguez on
	Weather looks good (maybe some small showers around
	the cape) TALs look good (except Banjul).
19:10	Briefing done
	P/Ls call us to see if we were here
19:30	P/L L-1 brief start
	Informed P/Ls of all status
	P/Ls said that we will go free drift
	during Hinge ops.
19:50	Briefing done / went to deliver MSX/SIMPLEX
	data to FDO console. Hols off.

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FLIGHT/SIM/TEST/ID	DATE	ORB	CONSOLE POSITION	PAGE
STS-93	19 JULY 99		DOD REP	2 of 22

TIME	FLIGHT EVENTS/HISTORY/BRIEFINGS
23:00 CST	Rodriguez and Hoge on console.
23:20	Dr. Bernhardt called. Wondering when he
	should call after launch.
23:39	Launch Aborted @ T-00:00:06
23:50	Crew getting ready to egress.
	Scrub opportunity for today. Launch aborted
	due to H2 unacceptable levels in Aft engine
	compartment. Determination for next attempt after
	recommendation from safety community.
20 July	
00:10 CST	Problem may be due to a faulty indicator, this
	leads to a 48 hour turn around. Igniters that
	worked will be removed and replaced.
00:40	Engelhardt on console.
01:30	Press conference
02:45	Rodriguez, Engelhardt, Rodriguez off console.

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FLIGHT/SIM/TEST/ID	DATE	ORB	CONSOLE POSITION	PAGE
STS-93	**21 JULY 99**		**DOD REP**	**3 of 22**

TIME	FLIGHT EVENTS/HISTORY/BRIEFINGS
11:30 CDT	Voice check performed with payloads
	on Payload Conference
12;30 CDT	FDO Requested updated MSX state vectors
12:45 CDT	Requested MSX state vectors from
	MSX operations, Alice Bowman.
1:15 CDT	Alice said Apollo having problems. It
	will take some time to reboot and make the
	run to obtain the MSX state vectors
3:25 CDT	The MSX state vector was placed on
	JSCMODM\DATA\Flt_supp\Flight\Inbox\Payload
	as file MSX_vector1,doc. The vector is
	28 minutes before nominal Launch. Payload
	Data busy with IUS. Will try to call later.
3:45 CDT	Bill said both Rey and himself will be
	at the office 3:30 am CDT. When you
	receive the Orbiter state vector you can
	put it on the Apollo for Rey Urbano and give him a call.
4:30 CDT	Propagated the MSX state vector to 5:28
	GMT and placed in file STS93_MSX.VAD. The
	previous STS93-MSX.VAD file was renamed
	to STS93-MSX.VAD.OLD. Use the STS93_MSX.VAD
	file on FADS for the analysis of MSX opportunities.
	The full path is /fads/dpsc/state_vectors/msx/STS93_MSX.VAD
5:00 CDT	Contacted Payload Data and gave them the
	location of MSX State Vector. Payload Data
	will send to FDO. Payload Data Requested
	status of CCM STL. Will try to get in touch
	with T. Hellner/Nichols.
6:00 CDT	Wrote flight note of pre-launch status of DOD
	payloads. File name is “DOD prelaunch status.doc”. Gave
	pager # of Capt. Hoge as contact until launch.
6:15 CDT	D. Walker off console.

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FLIGHT/SIM/TEST/ID	DATE	ORB	CONSOLE POSITION	PAGE
STS-93	**21 JULY 99**		**DOD REP**	**4 of 22**

TIME	FLIGHT EVENTS/HISTORY/BRIEFINGS
11:00 CDT	Capt. Hill, Capt. Hoge, Rodriguez on console
11:09:00	Paul Bernhardt called. He will contact Terry Hols as
	soon as he get in the hotel in Cocoa Beach.
00:24	• Launch scrubbed due to weather after extending
	window 20 minutes. Next attempt will be
	Friday, July 22 @ 00:24 EDT
00:25	Capt. Nichols called. Both STL-B & CCM-C will
	stay in. MEMS also remains in.
01:30	Hill, Hoge, Rodriguez off console.

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FLIGHT/SIM/TEST/ID	DATE	ORB	CONSOLE POSITION	PAGE
STS-93	**22 JULY 99**		**DOD REP**	**5 of 22**

TIME	FLIGHT EVENTS/HISTORY/BRIEFINGS
~11:30 CDT	Completed pre-mission analyses of MSX
	and SIMPLEX opportunities. Contacted Bill
	Dimpfl to initiate detailed analysis of
	MSX. Can not reach Paul Bernhardt to
	provide him the SIMPLEX analysis.
~12:00 CDT	Placed a new MSX state vector on Payload
	Inbox area for FDO. Full path name
	/JSCMODM/DATA/FLT_SUPP/FLIGHT/INBOX/PAYLOAD/MSX_VECTOR2
	Paged Capt. Nichols for status of CCM and
	STL-B.
12:05 CDT	STL-B is normal. CCM is a little warmer
	than desired. 39.5° which is 1 - 1.5°
	warmer than desired.
12:10 CDT	A MMT will be held at 1:15 - 1:45 CDT to
	discuss launch strategy. If weather is
	more favorable tonight they will tank
	and try tonight. If tomorrow is more
	favorable then they will not tank and try
	tomorrow. Enough Cryo is available for 1

	more launch attempt before a 5 day
	turnaround is required to refuel. August 18
	next opportunity if this fails for another
	launch. The current launch window is
	116 minutes starting 4:24 - 6:20 GMT July 23.
1:00 CDT	Wrote a brief flight note of status. Included
	the MSX state vector for FDO. The filename
	is DOD prelaunch status Jul 22.doc under
	the Payload Inbox.

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FLIGHT/SIM/TEST/ID	DATE	ORB	CONSOLE POSITION	PAGE
STS-93	**22/23 JULY 99**		**DOD REP**	**6 of 22**

TIME	FLIGHT EVENTS/HISTORY/BRIEFING
20:30 CDT	Hoge on console.
21:05 CDT	Capt. hill, Rodriguez on console
23:31 CDT	Lift-off with 7 minute delay.
0/00:00 MET	All systems nominal
0/00:02:06 MET	SRB Separation
0/00:40:19 MET	Go for OMS2 burn
0/01:14	Paul Bernhardt called. He'll be at hotel in Florida
	until 1300 EDT Friday 7/23/99. PH (407) 636-6500 Rm. 245
	Fax (407) 631-0513
0/01:39	Hols, Engelhardt on console.
0/03:00	Vectors from FDO for
	* FDO2 Begin * No Burn 1/20:00 -
	* BA Burn out
	* Post Fly cast
0/03:09	Crew call down
	Rail 1 39.1 Chamber temp 18.5
	Rail 2 39.0
	Rail 3 37.7
	CCM - Nominal activation went well -
0/03:23	STL-B - Temp 28.6
	MEMS - Normal Ops
	- Thermal Control Device - Impossible to tell
	change in state
0/03:31	Rodriguez off console.
0/04:12	MSX Data placed on Apollo site

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FLIGHT/SIM/TEST/ID	DATE	ORB	CONSOLE POSITION	PAGE
STS-93	23 JULY 99		DOD REP	7 of 22

TIME	FLIGHT EVENTS/HISTORY/BRIEFING
0/07:00	Faxed SIMPLEX analysis to PI (parts of analysis)
0/08:00	P/Ls called & asked about MEMS (Thermal Control
	Device). Wanted to know if they could
	do anything. Told him that he could no do
	anything at this point & that we will probably
	not see any difference throughout the mission.
	P/Ls also asked about MSX. He
	said they may put the MSX trajectory up on one
	of the FCR screens. We told him that
	we provided FDO a vector & that the
	satellite does not perform any maneuvers
	but merely changes attitudes.
0/08:30	e-mailed out a request to Alice Spring detailing
	Lat/Longs for time frames between 21:00 - 23:00
	GMT FOR AN AREA OF 10° S 120°e, 10°s 135°E,
	23°S 120°E, 23°S 135°E. -E-MAIL RETURNED - BAD ADDRESS
0/08:38	FAO asked about MSX & SIMPLEX analysis, asked
	for an additional hour.
09:00	SIMPLEX PI called, we sent Alice Springs data
	to PI's e-mail address. PI said he would
	work the Jic opportunity & set back to us.
0/09:15	MSX PI called with input - Gave us TIG for
	Jicamarca burn. Said he would call
	back here @ 20:00 central time.
09:54	10:00 EST, Alice needs final TIG for MSX.
10/12	MSX PI wanted pass 10 & 19 j2k vectors
	(with "test" in name).
	Luis called - wants me to contact Mike
	Golightly for a film pouch bag.

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FLIGHT/SIM/TEST/ID STS-93	DATE 23 July 99	ORB DOD REP	CONSOLE POSITION	PAGE 8 of 22

TIME	FLIGHT EVENTS/HISTORY/BRIEFING
0/10:23	Sent flight note to P/Ls & informed.
0/10:35	P/Ls asked about the MEMS TCD. He asked
	if we should delete the checking of the
	TCD. I said to give it one more day
	then we would probably agree to delete
	the check.
0/12:00	P/L Sys requested a status of P/Ls for crew
0/12:14	Tavanese on console
0/12:30	FDO call & ask for an MSX vector &
	stated that the MSX times were not what
	was in the FDO's console handbook
	I explained that we are only providing
	one MSX SV for the mission & that FDO
	could propagate it. He had no problem
	with this. I also explained that the
	MSX times will differ from the FDO's
	console handbook because of the delta
	in actual launch. He understood
	that there were would be differences &
	said he would get back to us in two or
	three hours. I also mentioned that
	the PI wanted a different attitude
	also (+xvv biased 68° nose <u>down</u>).
0/12:52	Go for all three MSX S-Band req.
0/13:00	Sent P/Ls status to P/L Sys (in Flight Notes)

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STS-93	**23 JULY 99**	**DOD REP**		**9 of 22**

TIME	FLIGHT EVENTS/HISTORY/BRIEFING
0/10:23	Walker on
	Passed on Alice request for other j2ks
0/15:00	Hols off
0/15:44	Provided Bill the scans and summaries etc.
	for MSX using the latest state vectors
	modeling the OMS adjust, SIMPLEX and
	flycast maneuvers. Bill anticipates
	INCO will have to select to another antenna
	during the pass. He wants to know the
	times they may switch due to a possible
	beacon receiver lockout problem during
	a switch of the antenna. Payloads busy
	over loop will ask later.
0/17:20	Placed the j2000 Orbiter State Vectors
	15 minutes prior to MSX burns 2 & 3 on
	the Apollo. (MSX computer site) E-mailed
	Bill and Alice Bowman.
0/18:6	To look at message, Bookmark “STARXE
	message status”. Under Netscape
	http://atd_b1/starxe Select
	STS-93. This will be required before
	uplink of flight plan before wake. Save
	files and view with Acrobat.
0/17:30	Nichols on
0/19:05	TIG-15 State Vector for Alice Spring burn #1 from FDO
0/1956	Paul Bernhardt @ Arecibo
	Rm. #224 787-878-2612 (phone) 809
	Office #305 87-787-878-1861 (fax)
	↑to dial not on our fax
0/21:14	Faxed update STL-B tape change scenario to Cannon @KSC
	Cannon & Dr Rove will be calling POCC ~ 15 prior to downlink

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FLIGHT/SIM/TEST/ID STS-93	DATE 23/24 JULY 99	ORB DOD REP	CONSOLE POSITION	PAGE 10 of 22

TIME	FLIGHT EVENTS/HISTORY/BRIEFING
0/21:35	Informed payload Sys that we would have more firm TIG times
	@ MET 1 day 6 hours - they're working timeline issues
0/22:34	Slipped Flycast maneuvering by ~2 minutes
	➘No input on SIMPLEX #1 burn (Alice Springs0
	➘Getting new vector (post-SIMPLEX #1) TO CHECK MSX
0/22:51	Dr Bernhardt confirmed that SIMPLEX #1 was good to go
	Will make call to payload Sys @ at ~ TIG-3 hours
0/23:09	MSX #1 changed by < 1 second due to burn slip for Fly-cast
0/23:11	Faxed updated STL-B Tape change schedule to Tom Cannon
0/23:21	Asked if TV DNLK was a type where STL-B is INIT
	➘checking to confirm live downlink @ INIT
0/23:43	Gave a Go for SIMPLEX burn #1 centered @10° South as planned
0/23:43	P/L SYS confirmed STL-B would receive live downlink
	at STL-B INIT
0/23:43	CDR called down rail temps for CCM-C.
	Rail #1 37.5
	#2 37.6 called info in to
	#3 37.0 Tom Cannon
	Chamber 16.1
1/00:30	Terry Hols, Johnny Engelhardt On console
1/00:05	Capture MSX TIG-15 Vector & Burn plan
1/00:32	Probably going to get ~35 min of STL-B live D/L
1/00:45	Reviewed SV for 01/6:20, SIMPLEX #2 analysis
1/01:05	Tom Cannon called with phone numbers at the E.M.A.
	in hanger L 407-853-7703 and 407-853-4145
1/01:07	P/L & FAO told us that STL-B will not get it's
	full 45 minutes of live downlink , so we will
	delay the STL-B INIT until TDRS-E AOS, and
	get about 30 minutes of video.

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FLIGHT/SIM/TEST/ID	DATE	ORB	CONSOLE POSITION	PAGE
STS-93	**24 JULY 99**	**DOD REP**		**11 of 22**

TIME	FLIGHT EVENTS/HISTORY/BRIEFING
1/1:8:40	received updated TIG time for
	SIMPLEX burn over Jicamarca
	is now 1:6:34:56.0 MET. Longitude 76.87 stop.
1/1:16	Crew call to delay STL-B Downlink to TEAOS
1/1:18	Capt. McCamish on console
1/2:11	STLB INIT started.
1/2:15	STLB - Temp 28.6
1/3:00	D. Walker off console
	FDO told flight that the SIMPLEX
	OTHR burn was ~9.1 ft/sec. This is
	a good burn.
1/03:50	Got SV’s for next day planning
1/03:51	Received approximately 27 minutes of “live”
	STL-B video downlink. INCO reconfigured
	the video loops to allow the live down
	link to be broadcast over NASA Select, so
	that Tom Cannon & company could view
	the downlink at KSC. The video images
	do not appear to be well-focused, so we
	have requested that the crew perform
	steps 1-4 and 10-14 of the manual &
	re-zero camera procedures, in an attempt
	to provide better images of the fern cells.
1/04:19	More STL-B downlink, but not on NASA Select
1/04:26	CAPCOM request PLT perform manual & re-zero
	camera ops.
1/04:30	PLT beginning to work STL-B focus
1/04:40	Tom Cannon is happy with the re-focus work
	Capt. Nichols off console.
1/04:50	Hellner off console.

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FLIGHT/SIM/TEST/ID	DATE	ORB	CONSOLE POSITION	PAGE
STS-93	**24 July 1999**	**DOD REP**		**12 of 22**

TIME	FLIGHT EVENTS/HISTORY/BRIEFING
1/05:07	MSX PI gave us a 30 second TIG display
	for the MSX burn
1/05:24	5/49:10 ULA (Upper Left Aft)
	/54:45 LLA
	/58:20 LLF
	Antenna Selection
	FDO said got 20 ft/sec burn?
1/06:00	Got good MSX burn
1/06:21	Cell completed in focus
	want not to refocus "deeper" in - on spores not Grid
	* Execute STL-B manual & re-zero camera operations -
	steps 1-4, to 10-14.
1/06:34	2 OMS burn for SIMPLEX - ΔV = 9 ft/s
1/06:50	Jeff ran camera all the way in, no
	focus on some cells - set camera all the
	way in and reset to automatic
1/06:57	MEMS status - OK
	-TCD - Some rows changing - cannot be more specific
	---**Lessons learned - Do not locate near floor!!**
1/07:03	STL-B status - 29.0

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FLIGHT/SIM/TEST/ID	DATE	ORB	CONSOLE POSITION	PAGE
STS-93	**24 July 1999**	**DOD REP**		**13 of 22**

TIME	FLIGHT EVENTS/HISTORY/BRIEFING
1/07:21	Jicamarca data results
	-- Data looks good
	-- Data is still being gathered
	-- Calibration for "fine" data in process.
1/8:48	Engelhardt off console
1/9:30	CCM 1 5 46 MET 1 9 03
	37.6 37.6
	37.7 37.7
	37.0 37.0
	15.6 Chamber 16.6 Chamber
	B. Dimpfl (787) 273-4775 x 241
1/10:00	B. Dimpfl called set TIG for MSX 2
	@ 2/06:01:16 MET with a TIG slip of
	100 seconds

10:15	McCamish off, Nichols on
1/10:49	SIMPLEX PI called wants to change the
	Kwajalein & Arecibo burns form dual to single
	talked to FDO. He said its Okay asked me
	(robert.p.stern1@jsc.nasa.gov)
	to e-mail the new TIGs to him @ ↑
1/10:24	Saved flight note to P/Ls.
1/12:18	Saved FD2 status page for crew.
12/40	Reviewed Δ's to Hinge Ops for free
	drift. Told P/L Sys it looked fine to
	us
1/13:26	Walker On Console

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TIME	FLIGHT EVENTS/HISTORY/BRIEFING
	another number at the office in
	Arecibo x305 Stop Kwajalein burn at TCA
1/15:43	Requested STL-B TV live feed for
	45 minutes. This appears to be
	deleted from the flight plan.
1/16:17	Hoge off
1/16:17	Hill on console
1/16:30	Payload data relayed potential conflict between
	STL TV downlink and SUISS downlink. DOD
	Rep replied that full 45 minutes downlink is
	required. Waiting for final resolution of
	issue.
1/16:41	Payload officer discussed (over loop) that STL-B
	downlink is mandatory (pre-flight rule) so
	SUIS-Jupiter downlink will be taped
1/16:44	Payload Officer confirmed w/DOD Rep that
	live downlink of STL will occur - waiting
	for confirmation that downlink will be 45 min
1/16:51	Bill Dimpfl called and said MSX burn 1
	was seen by the satellite.
1/18:00	Hellner on console
	went to P/L MPSR (Rm. 217) to discuss
	getting as much STL-B D/L on NASA Select
	as possible. They will do what they

	can to remind PAO & INCO about this
	request when there is a downlink.
1/18:15	Nichols on console
1/19:11	Received SV for SIMPLEX burn @ 2/1:18:03 to update the TIG
1/19:15	FCT talking about Middeck Science checks. No requirement for
	call-down's of MEMS checks

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TIME	FLIGHT EVENTS/HISTORY/BRIEFING
1/19:21	Need times for additional 2 STL-B downlinks

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	3/22:11 → 4^{th} STL-B D/L ⌈ then we'd have forgotten them both
1/19:56	Capt. Nichols coordinated the above downlink
	requirement with 3^{rd} & 4^{th} downlinks inserted
	into timeline.
1.20:00	Updated TIG time for Kwajalein burn 2/01:18:01
1/20:10	Upcoming STL-B downlink will be split into 2 parts due to Ku coverage
1/20:35	Received SV for Alice Springs burn planning
1/20:54:00	Rail #1 37.9
	Rail #2 38.0
	Rail #3 37.0
	Chamber 16.3
1/21:35:xx	Provided FDO with a "GO" call for the upcoming Kwajalein burn
	Alice Springs TIG
1/21:50	29.1 STL-B → operations nominal (waiting for D/L)
1/21;50	MEMS operating nominally except for TCD
1/22:11	P/Ls waiting some of the STL-B D/L time for SWUIS
	➘ responded no until we get what we need
1/22:22	Begin STL-B downlink on NASA Select
1/23:02	PLT performing manual scan of each of the 3
	chambers, then he will call down when
	he's ready to go to automatic mode.
1/23:00	Hols & Engelhardt on console
2/00:11	State vector for MSX2 Burn - Vector looked good
2/00:39	Kwaj vector call - looks good -
2/00:44	Call to crew for OMS configuration
2/01:18	Δ9:1 ft/sec burn Kwaj → good data

TIME	FLIGHT EVENTS/HISTORY/BRIEFING
2/1:31	Vector request - METS 2/19:00
	3/03:00

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	Paul Bernhardt called & said Kwaj
	got good data. They will continue
	to take data for another hour or so
	and give data to PI.
2/2:09	Confirmed w/FAO that we do want 2 additional downlink
	sessions
2/2:10	ALS2 burn call up to crew -
2/2:20	Walker off (Bill Dimpfl @ home
	(978) 369 - 1750)
2/2:38:31	Δ 9.2 ft/sec - good burn -
2/02:56	Got planning vectors from TRADa
2/03:26	Starting HINGE
2/04:08	MSX-SIMPLEX analysis complete and put on Apollo.
2/04:18	HINGE - Start free drift
2/04:52	HINGE - No problems → all is well → went very well
	DEPLOYED ALL 6 -
2/4:30:00	CCM Status
	Rail 1 37.7
	Rail 2 37.8
	Rail 3 37.0
	Chamber 15.7
2/5:16	Bill called MSX is go for burn &
	tomorrow's TIG is MET 3/06:03:16 with
	a 115 second TIG slip
2/5:20	Nichols off console
2/5:45	Sent flight to P/L Sys on MSX/SIMPLEX
	opportunities

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STS-93	**25 JUL 99**	**DOD REP**		**17 of 22**

TIME	FLIGHT EVENTS/HISTORY/BRIEFING
2/06:09	FDO reported good burn - 11.85 total ft/sec
	2.8 PRCS ft/sec
2/06:11	status
2/06:32	STL-B temp 29.1
	MEMS - nominal - can't tell if TCD changes -
4/6:42	payload approved FLT - note for MSX, SIMPLEX
	burns
2/8:30	Engelhardt off
2/10:50	e-mail from SIMPLEX PI describing
	Kwajalein results.
2/12:30	Walker on, Capt. McCamish on.
2/16:40	The flight plan was reviewed for
	FD4. Capt. McCamish had to remind
	Payloads to include all the STL
	tape changes.
2/17:17	Faxed STL-B tape change times per Flight Plan
	to Tom Cannon (P.I.)
2/18:40	D Hill on console, S. McCamish off console.
2/20:28	Received state vector for Alice Springs
2/20:37	STL-B Temp 29.1
2/20:40	CCM Status:
	Rail 1: 37.1
	Rail 2: 38.0
	Rail 3: 37.0
	Chamber: 16.6
2/21:02	Asked payload Sys @ MEMS status - told that
	call-down status was not required (which
	was understood) however, I related to Payload
	Sys our 'concern' over MEMS TCD. Waiting
	for reply…

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TIME	FLIGHT EVENTS/HISTORY/BRIEFING
2/21:10	Payload Sys called Payloads about MEMS status - told
	that crew members are busy as "one-armed
	paper hanger", so no status right now.
2/21:35	Nichols on-console
2/21:53	Hill off console.
2/22:15	Hols on
2/22:45	Provided a Go call to FDO on upcoming SIMPLEX op
2/23:22	Hellner on console keeping the metropolis safe
	(visions of grandeur)
2/23:35	Johnnie on
3/00:00	Requested vectors (Got vectors
	METs 3/05:30:00 & 4/00:00:00
3/01:00	Analysis for MSX on Apollo
	SIMPLEX analysis for tomorrow complete
3/01:12	STL-B video downlink begins
	* contact w/PI - Tom Cannon wants to run
	refocus/manual OPS w/5 minute per chamber -
3/01:34	Lost video down for ZOE - Capt. Nichols & Todd Hellner went to visit Payloads back room
3/2:01	Dimpfl called wanted to get the times that
	the S-Band was initiated for the first two
	burns
3/02:06	STL-B discussion w/Payloads Officer on change
	of Step 11- Focus then move in six bumps.
	- Video requested -
3/02:12	- Payload Officer to Flt.
	Need 45 min video in 2 hours - not optimistic
	Need 5 min procedure for Re-Zero
	➘ want 50 min procedure - activity problem
	➘ Plt. to do 10-4 ~ MET 3:03:

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TIME	FLIGHT EVENTS/HISTORY/BRIEFING
03/02:38	- Good burn - SIMPLEX ALS3 -
03/03:07	- Call to crew Page 10-4 -
	- Entire procedure step 11 - add Push in button 6 times
	- performed six times -
03/03:13	- No deltas for MSX TIG times -
	- Request S-band turn on times for first two
	MSX times - (1) GMT 205/10:21 Off 10:31
	(3) GMT 207 /10:34 off 10:44 (2) GMT 206/10:24 Off 10:34
03/03:24	Payloads Officer suggestions -
	- verify video not disrupted by
	TEDRIS conflicts -
03/03:37	Re-adjust MSX3 S-Band turn on to
	8 min prior to burn -
3/04:12	Crew call - removed camcorder from
	from STL-B for TVIS Ops -
	⇒ move camcorder from SUWIS ⇒
3/04:15	⇒ Video camera back on STL-B
3/05;00	CCM Status
	Rail 1 38.4
	Rail 2 38.5
	Rail 3 37.4
	Chamber 16.7
	Capt. McCamish on
3/05:19	Man over PAO on board -
3/06:03	Good BURN - MSX3 ΔV= 9 ft/sec
	MSX Burn completed -

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3/07:11	Relayed to P/L Sys new TIG for
	Arecibo (MET 4/00:17:59)
3/07:31	MEMS normal, might have seen 1st row
	change but no others
3/09:28	Told FDO about new TIG time for
	Arecibo
10:13	Sent out P/L status note for the crew
	(copy in Flight Notes)
10:20	Capt. Tavanese on
10:30	Capt. McCamish off
3/11:30	Darrin Walker on console
2/13:00	Reviewed flight plan FD4. STL TV
	schedule 3/22:00
3/13:53	Ran detailed Lat, Lon, Elv Report
	faxed to Paul Bernhardt for Arecibo burn.
3/15:08	Updated STL tape change schedule and
	fax'ed to Tom Cannon
3/15:34	Hill on console; Tavanese off console
3/16:05	Payload requested DOD Rep inputs in case
	landing is delayed 24 hrs.
3/18::12	Receiver TIG-6 vector for Arecibo site
	no difference between TIG-6 and TIG-8 results.
3/18:45	Submitted inputs to Payloads for an extended
	day. Flight Note DOD Payloads extended day.
3/18:52	CCM-C Status checks done 3/18:33:00
	Rail 1 37.2
	Rail 2 37.8
	Rail 3 37.0
	Chamber 16.1
3/19:48	Paul Bernhardt called and was informed that the
	information was on the Fax machine

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TIME	FLIGHT EVENTS/HISTORY/BRIEFING
3/20:20	STL-B and MEMS status check still
	can't see a change in the TCD
	at 3/20:07 STL temp was 29.2
3/20:21	Talked to Paul Bernhardt and he is ready
	for Arecibo burn. He also provided a
	more accurate Arecibo Lat, Lon 18:344S,
	-66.7531.
	Hellner on console
3.21:13	Informed Payload Data that there is
	no update to the Arecibo TIG time.
	TIG is still 4/0:17:59.
3/2:56	Hill off console
3/13:15	Nichols on-console
3/22:00	STL-B downlink began at approximately this time.
	the PI requested that the crew re-zero
	the cameras.
3/23:38	PLT confirmed that he has completed re-zero
	ops & will continue recording thru
	STL-B entry prep.
4/0:18:26	9.1 fps Burn over Arecibo.
4/0:24	D. Walker off console.
4/01:45	MS2 ready to begin STS-B Entry Prep
4/01:52	STL-B Entry Prep complete
4/01:55	Rail 1 37.1
	Rail 2 37.6
	Rail 3 37.0
	Chamber 15.4
4/02:56	29.0 STL-B nominal set up for entry
4/03:20	Nichols off console

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TIME	FLIGHT EVENTS/HISTORY/BRIEFING
4/15:43	Capt. Hill, D. Bromwell, L. Rodriguez on console
4/15:50	Notified Payload Sys that DOD Rep is on console
4/15:51	CSR notify DOD to contact CCM PIM
4/15:55	DOD Rep contacted CCM PIM - asked to
	fill out payload mission success form and
	send in. DOD explained to CCM PIM that
	mission success for 4/6 payloads could not
	be determined until post-mission analysis
	CCM PIM will talk w/CSR Reps and get
	back to DOD
4/16:40	DOD Rep asked Payload Sys to verify
	timeline for CCM pre-entry Prep
4/16:48	Response was: 4/17:30
4/17:25	provided CCM PIM Payloads Mission Success status
4/17:31	Sent an e-mail to Michelle P. Lewis CCM Payload
	Mission Success status
4/17:39	CCM status
	Rail 1: 36.9
	Rail 2: 37.5
	Rail 3: 37.0
	Chamber 15.5
4/18:53	Hill, Bromwell, & Rodriguez off console
Note:	Columbia successfully landed on 27 July 1999
	11:20:35 p.m. EST (110:20:35 p.m. CDT) @ KSC

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